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ABSTRACT

As a supplement to Learning Activity Packages (LAP) on the time-space-matter subject, details are presented for self-directed activities. Major descriptions are given on the background of LAP characteristics, metric system, profile graph construction, spectroscope operation, radiant energy measurement, sunspot effects, density determination, dimensions of the earth, and radius computation by use of shadows. The remaining LAPs grouped in the experiment category are concerned with the moon's origin and characteristics, radiation aspects, and identification of rocks and minerals. Tables of average summer temperatures in New Haven and annual sunspot numbers are included. Also provided is a list of slides on Apollo missions. (CC)

ED 070673

INDIVIDUALIZED INSTRUCTION IN SCIENCE

Self-Directed Activities

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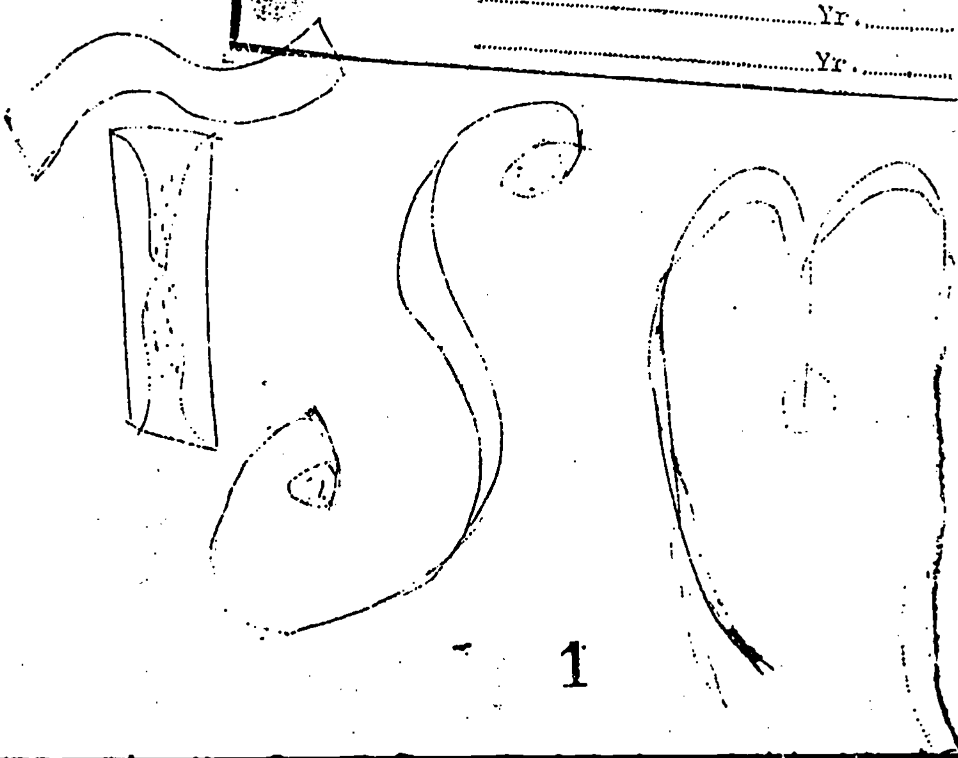
T.S.M.

Time, Space, Matter



SE 015 490

ACTIVITY I-1-1
A STUDENT GUIDE
AS TO WHAT IS CONTAINED IN A LEARNING ACTIVITY PACKAGE

First, let us answer the question, "What is a LAP?" A LAP or Learning Activity Package, is a set of directions for obtaining specified objectives. It doesn't teach you but rather guides you in obtaining the information you need. Different methods are suggested for your learning. How much you learn depends on you even though your teacher will always be on hand to help.

Just how the directions are carried out and the objectives achieved depend on you as an individual. This means that, instead of always working with the rest of the class as a group, some of the time you will be working on your own as an individual. You will cover the same material that you would have covered as a group but there are greater benefits to you as an individual, such as:

1. YOU WILL BE WORKING AT YOUR OWN SPEED.
   If you feel, however, that you need extra time, you may finish at home the work not completed at class. This will be your "homework".

2. YOU WILL HAVE THE OPPORTUNITY TO TAILOR THE PROGRAM TO YOUR OWN REQUIREMENTS.
   Because of previous knowledge or experience, you will be free to concentrate more thoroughly on that material with which you are not familiar.

3. YOU WILL HAVE THE OPPORTUNITY TO SELECT THE METHOD YOU WISH TO FOLLOW IN LEARNING.
   Visual aids, such as, film loops or slides, may help you to understand the material in addition to choice of reading references and experiments.

4. YOU MAY WISH TO WORK BY YOURSELF.
   Even if equipment is limited, you will still be able to have your turn. Sometimes, however, after having completed your individual work, you might find it helpful to compare and discuss your results with others.

Some real advantages have been presented. They should be of benefit and make your work more enjoyable, but, as the saying goes, "You never get anything for nothing." Your contribution is to accept responsibility. No one will be checking constantly to make sure you are working. However, in one way or another, after you have completed the assignment, your knowledge must be tested so, to assure success, you will find it necessary to depend on yourself. However, your teacher will be there to help and guide you.

Let us now take a look at some of the things that make up a LAP:

1. A written guide including:

    a. Unit - the major idea proposed to be learned
    b. Topic - the specific area to be explored
    c. Objectives - goals or guidelines , the achievement of which will help to show your mastery of the learning
    d. Activities - designed to enable you to fulfill the objectives.

    Each Activity has its own set of instructions.

    For purposes of identification, the activities are numbered with the Unit number followed by the Topic number and the particular activity number. For example, I-2-6 stands for Unit I, Topic 2, Activity 6.

2. Vocabulary sheet - to help you to remember new words learned and their correct spelling.

3. Self-Evaluation Test - to test yourself when you think you have mastered the Topic.

4. Answer Sheet for the Self-Evaluation Test. You will mark your own test and use it to recheck your learning.

5. Pre-Test - You will be given a pre-test for a Unit on a Topic to determine your weak and strong points.

6. Post-Test - This is a test designed to see if you have successfully completed sufficient activities and understand the work.

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You will be expected to keep a notebook which will become your "textbook" and will be needed for review and testing. In addition to the Vocabulary Sheet and the notes you will take as you go through activities and reading, you will keep in this notebook ORIGINAL copies of your activities, the CARBON copies of which will be handed in and then returned with suggestions for rechecking where necessary. In this way, you will be responsible for correcting your own originals and inquiring about points you do not understand.

In order to check on your progress, you will need to obtain a STUDENT PROFILE sheet which you will keep in the front of your notebook. This STUDENT PROFILE will give you a quick summary of the activities you have completed, how well you are doing, and how long it is taking you to do them. You may want to improve your achievements if they are not what you want them to be, or you may wish to think over better use of your time.

Your grade will consist of the following:

1. Amount of work done (a MINIMUM as well as MAXIMUM number of activities will be posted.)

2. Post-Tests taken.

3. Work habits, including:
   a. Use of class time
   b. Care of equipment
   c. Neatness in writing reports
   d. Following directions
4. Attitude or Citizenship
   a. Dependability and honesty
   b. Self-discipline (talking quietly and only when necessary, for example).
   c. Cooperation in clean-up and keeping environment orderly.

TSM 8th

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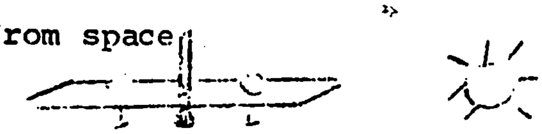
Experiment II-1-6

I. INVESTIGATION: Do the phases of the moon depend on the way in which light is reflected from the sun?

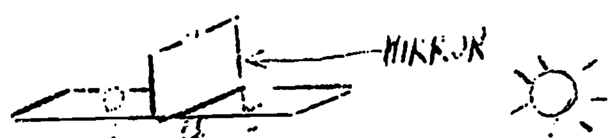
II. EQUIPMENT: Light source
Styrofoam balls (two-representing the earth-moon system)
Bank pins
Balance beam (metric ruler)
Mirror
Large empty spool
Straw

III: PROCEDURE:

A. apparatus for moon as viewed from space



B. apparatus for moon as seen from earth



C. On a separate sheet of paper, using a protractor, make a circle 8 cm in diameter and then an inner circle of 4 cm.

D. Divide the circle into 8 equal parts. At the intersection of circles and radii, make 8 small circles on the inner ring and 8 circles on the outer ring, each with a radius of .5 cm (5 mm).

E. Mark the outer circle: VIEW OF THE MOON FROM SPACE
Mark the inner circle: VIEW OF THE MOON FROM EARTH

F. Align the earth-moon system so that you can reproduce the views shown on pages 10-11. A mirror, taped to the center straw will indicate the view of the moon from earth. Looking down at the system will indicate the view from space.

IV: OBSERVATIONS: (to be made on the circle chart)

A. Indicate with arrows the direction from which the light source is coming (the sun).

B. Fill in the small circle (representing the moon) to show shadow and light areas of the phases of the moon as you see them on the apparatus, from the earth and from space.

C. Record on the diagram in centimeters the actual distance between moon and earth which you found you needed to reproduce the correct phases.

V: RESULTS:

A. How much of the moon's surface is illuminated at any one time?

B. As you experimented to find just the right conditions with which to reproduce the phases of the moon, did it make any difference as to the distances you used?

C. How long does it take for each of the three cycles of change to take place?

D. Does the amount of lighted surface appear to change evenly or unevenly over the intervals of time shown?

E. What happens to the size of the moon throughout its cycle?

F. Summarize your experience by answering the question posed in the Investigation.

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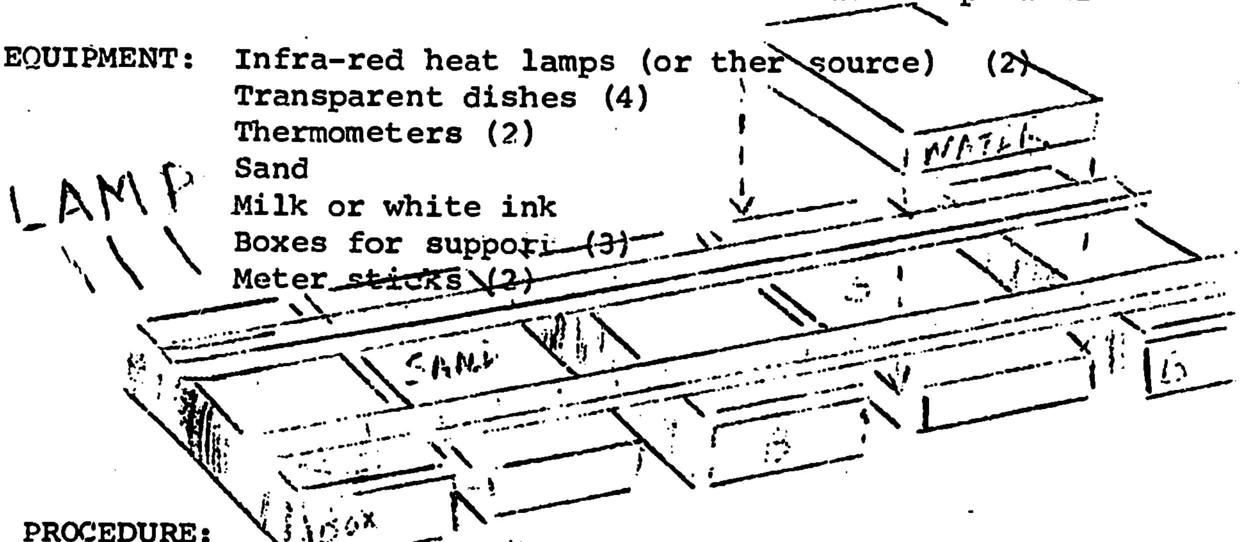
Experiment II-1-7
A.

I. INVESTIGATION: Does the lack of a dense atmosphere on the moon result in extreme surface temperatures?

II: EQUIPMENT: Infra-red heat lamps (or ther source) (2)
Transparent dishes (4)
Thermometers (2)
Sand
Milk or white ink
Boxes for support (3)
Meter sticks (2)



III: PROCEDURE:

A. Assemble apparatus as shown in diagram
B. Fill 2 clear dishes with sand
C. Fill 3rd clear dish with water and the 4th with milky or white inky water.
D. Insert thermometers so that bulb tips are below the surface of the sand.
E. Turn on both lamps
F. Record temperature readings of both thermometers every 15 seconds for approximately 10 minutes or until temperature stabilizes.

IV. OBSERVATION: Tabulate your readings in a suitable chart.

V: RESULTS:

A. Explain how you would relate the apparatus set-up to the moon's temperature.
B. Answer the question in INVESTIGATION

QUESTIONS FOR DISCUSSION:

1. How could you vary the density of the atmosphere in this demonstration?
2. What effect does the height of the dishes containing the liquids have on the soil temperatures?
3. How could this apparatus be used in demonstrating night and day temperatures on the moon's surface?
4. Since there is no water on the moon at present (on the surface), but the surface does seem to indicate wear, how could this be accomplished?

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Experiment II-1-7
B.

I. INVESTIGATION: Do the reflective qualities of a body in space indicate the nature of its surface texture?

II. EQUIPMENT: Source of light (gooseneck lamp)
Colored paper
Sand paper - fine to coarse
Foot candle or light meter

III. PROCEDURES:

A. Shine the light at an angle on paper. Note the reading on the meter.
B. Shine the light at an angle on various grades of sandpaper. Note the readings of each.
C. Experiment with different colors and note readings.

IV. OBSERVATIONS:

A. Record your readings in a table.
B. Establish a scale of reflected light from the smallest to the greatest amount of reflection.

V: RESULTS: Answer the question posed in INVESTIGATION.

QUESTIONS FOR DISCUSSION:

1. Using your scale of reflected light, discuss the possible nature of the moon's surface and the amount of light it might reflect.
2. Repeat the above discussion but with the earth as the body in space.
3. Why do some areas on the moon appear darker than others?
4. What types of problems, due to light reflection, might our astronauts experience while on the moon?
5. Why do you think the astronaut's sun shield is made of gold?

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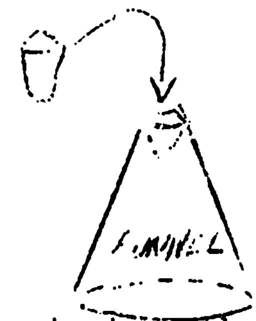
Experiment II-1-7
C.

I. INVESTIGATION: Why do some scientists believe that many of the lunar craters are of volcanic origin?

II: EQUIPMENT: Photos of the moon's surface
Thimble or crucible
Plastic funnel
Ammonium dichromate crystals



III. PROCEDURES:

A. Make a drawing of the apparatus before starting the next step.
B. Fill the container with ammonium dichromate crystals.
C. Light a match and apply it to the crystals.
D. Make a drawing of the apparatus after the crystals have stopped their activity.

IV: OBSERVATION:

A. Note the color of the chemical before and after the activity.
B. What do you think caused this?
C. What observation can you make concerning the volume of the ash compared to the original amount of ammonium dichromate?
D. Locate craters on your moon photos showing characteristics similar to those made in your drawing after activity.

V. RESULTS: Answer the question in INVESTIGATION based on your observations.

DISCUSSION QUESTIONS:

1. Have any of the Apollo missions confirmed the belief stated above? Find information in the library concerning this.

2. To what theory of the formation of the moon does this point?

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Experiment II-1-7
D.

I. INVESTIGATION: What is the basis of the theory that the moon originally came from the earth?

II. EQUIPMENT: Globe
Map of the Pacific Ocean floor

III. PROCEDURE:

1. Examine the general shape of the Pacific Ocean
2. Examine the Pacific Ocean floor map

IV. OBSERVATION:

1. Is there anything in the shape of the areas observed that might suggest an earthly origin for the moon?

2. What further observations would have to be made?

V. RESULTS: Answer the question in INVESTIGATION.

DISCUSSION QUESTIONS:

1. What are the other two theories concerning the moon's origin?

2. What experiments have been set up on the moon by the astronauts to test the theories?

3. In addition to the experiments, what other evidence from the moon is important in making a decision concerning the moon's origin?

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Experiment II-1-7
E.

I. INVESTIGATION: Does the nautre of the moon's surface and the nature of the moon itself require a special type of surface vehicle for transportation?

II. EQUIPMENT: Rover A - Oak tag
Pencil
Tape
Scissors
Stapler

Rover B - Wire mesh
Zinc Strips
Photographs or drawings of LRV

III. PROCEDURE:

A. Rover A
1. Cut 2 oaktag strips 5 cm X 45 cm.
2. Cut 6 strips of oak tag 5 cm X 7.5 cm from one of the 5 cm X 45 cm strips.
3. Staple 7.5 cm strips to the 45 cm strip at 5 cm intervals.
4. Draw ends of long strip together to form the rim of the wheel.
5. Attach loose ends to the pencil.

B. Rover B
Using the photographs given, make a model of the wheels of the LRV used on the moon by Apollo 15.

IV: OBSERVATION:

1. Roll the two wheels over different heights and shapes of rocks found in the laboratory.
2. Record the advantages and disadvantages of both types.

V. RESULTS:
1. State the nature of the moon's surface and the nature of the moon itself that are pertinent in designing a moon rover.
2. Answer the question in INVESTIGATION.

DISCUSSION QUESTIONS:
1. What other types of transport can you visualize that might be needed on the moon when colonization becomes an actuality?
2. What kind of vehicle might be necessary on Mars?

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Experiment II-1-7
F.

I. INVESTIGATION: How does the moon's gravity affect mass and weight?

II. EQUIPMENT: Coffee cans (7)
each filled with 454 gm (1 lb)
Basket or other divice with which to lift the cans

III. PROCEDURE:

1. Lift the six cans together in a basket using one hand and then, while still holding the six, pick up and hold one can.

2. Holding the six cans, try to walk, jump in place, and run slowly.

3. Replace one can for the six and repeat the activities in #2. Record your reaction.

IV. OBSERVATION:
1. Make a chart of your observations.
2. Record your weight as it exists on the planet Earth.
3. Read page 414 in EARTH SCIENCE (Silver Burdett). Record any notes.

V. RESULTS:
1. If the six cans represented the force of gravity on the earth and the one can represented the force on the moon, what ratio was established?
2. Estimate your weight on the moon.
3. Calculate your mass on the planet Earth (in grams).
4. What would be your mass on the moon?
5. Answer the question in INVESTIGATION.

DISCUSSION QUESTIONS:
1. Does a weightless object have mass?
2. If Jupiter's gravity is 2.6 that of Earth, how many cans of sand would you prepare to add to the experiment above?
3. What would your weight on Jupiter be? Your mass?
4. Given the surface gravity of the planets, what kinds of vehicles would you construct for travel on: M(.4) V(19) E (1) M(4) J(2.6) S (1.1) U (1) N (1.5) P (?)
5. What effect would there be on spacecraft entry and rocket liftoff on the various planets?
6. How would differences in gravity affect man's ability to do work on the various surfaces?

APOLLO MISSIONS
Slides

GROUP I: (Back side of the Moon moving West to East)

1. International Astronomical Union Crater
2. Mare Mescoviense
3.4. Crater Tsielkevsky
5. Crater Neper
6. Crater Shubert J
7. Crater Firmicus
8. Sea of Crises
9. Sea of Nectar
10. Sea of Tranquility
11. Landing Site 2
12. Crater Ritter
13. Crater Schmidt
14. Ariadaeus A and Rima Ariadaeus
15. Crater Godin
16. Crater Triesnecker and Rilles
17. Apollo Landing Site 3
18. Davy Crater Chain

GROUP II: (On the surface of the moon)

1. Close up of Astronaut's foot
2. Footprint in lunar soil
3. Closeup view of crater
4. Lunar mound
5. Flank of Cone crater
6. Close up of lunar terrain
7. Close up of lunar surface powder
8. Field of boulders
9. Cluster of boulders
10. Lunar rock
11. Large Boulder
12. Large boulder
13. Large boulder
14. Lunar stone closeup
15. Lunar rock closeup
16. Closeup of lunar surface
17. Lunar rocks

APOLLO 10

1. Apollo 10 Astronauts
2. Apollo 10 emblem
3. Apollo 10 emblem
4. Liftoff
5. Liftoff
6. Launch Control Center
7. CSM
8. Docking approach
9. Splashdown
10. Recovery
11. Recovery
12. Lunar landing site 1
13. Crater Apollonius
14. Crater Taruntlius
15. Crater Lubbeck
16. Highlands area
17. Crater Sabine
18. Crater Censorinus
19. Crater Censorinus
20. Crater Lade
21. Crater Maskelyne
22. Hypatia Rille

APOLLO 11

1. Crew
2. Astronaut Neil A. Armstrong, Commander
3. Astronaut Aldrin
4. Insignia
5. Aldrin descends LM ladder
6. Adfrin egresses LM
7. Aldrin's first step onto the moon
8. Astronaut Aldrin & LM foot pad
9. Adlrin & US flag
10. US flag on the moon
11. Moon Plaque
12. Lunar rocks
13. Aldrin deploys EASEP
14. Deployment of PSEP
15. PSEP deployed
16. PSEP deployed
17. Solar Wind Composition deployed
18. Aldrin sets down LR-3
19. View from LM window before ascent
20. Ascent stage
21. Recovery
22. Crew returns home
23. Rock box returns
24. Container of lunar rocks

APOLLO 12

1. The crew
2. Insignia
3. Liftoff
4. Liftoff
5. Liftoff
6. Liftoff
7. CSM during rendezvous
8. LM descent stage
9. Astronaut on LM ladder
10. Unfurling the flag
11. LM foot pad
12. LM interior
13. LM and astronaut
14. LM, astronaut, and S-band antenna
15. Lunar hand tool
16. Passive seismic equipment
17. LM, astronaut and TV camera
18. Astronaut uses LEC
19. Astonaut at Quadrant II
20. Astronaut at Quadrant II
21. Astronaut at Quadrant II
22. Astronaut carrying ALSEP
23. Astronaut with ALSEP
24. Astronaut with ALSEP
25. ALSEP deployment
26. Components of ALSEP
27. Central station of ALSEP
28. Central station of ALSEP
29. Earthwise ever lunar horizon
30. Earth rise ever lunar horizon
31. Sun eclipse
32. Recovery
33. Recovery

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APOLLO 13

1. The plaque
2. Mission operations control room
3. View of damaged service module
4. Damaged service module
5. The "mail box"
6. Lunar module
7. Interior view of "lifeboat"
8. Recovery

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APOLLO 14

1. Crew
2. Emblem
3. Plaque
4. Suiting up
5. Entering the transfer van
6. White Room
7. Kennedy Space Center - Control Room
8. Launch sequence
9. Liftoff
10. Liftoff
11. Earthrise
12. Lunar module
13. Lunar module
14. Astronaut on lunar surface
15. Commander Shepard on the moon
16. Third flag implanted on the moon
17. Moon surface
18. Equipment transporter
19. Equipment transporter
20. MET tracks
21. ALSEP's Central Station
22. ALSEP's Central Station
23. Components of ALSEP
24. SIDE
25. Close-up view of SIDE
26. PSEP
27. PSEP and ALSEP

ACTIVITY II-2-3
INTRODUCTION TO METRIC SYSTEM
Linear Measurements

Our system of measurement in the United States (the English system) seems fairly easy to us. We know that, for example, 1 foot is equal to 12 inches or that 1 yeard equals 3 feet because we have used these figures all our lives. However, what about considering how many inches there are in 6,721 yards? In order to get the answer, we have to multiply:

```
   6721
X     3  (1 yard = 3 feet)
  20163
X    12  (12 inches = 1 foot)
 241956  in.
```

Suppose, instead of doing all that multiplying, you could just move a decimal point? How many millimeters in 6721 meters? Since the Metric system is based on tens, and there are 1000 mm (millimeters) in one m (meter), to find out how many mm in 6721 m, all you need to do is move the decimal point three places (thousands):

6721 m = 6721 000 mm

understood decimal

Most of the world feels that moving decimal points is much easier and more accurate than multiplying various units as in the English system. Therefore, most of the world today uses a system of measurement called the Metric system. Instead of having to worry over fractions, inches, feet, yards, rods, furlongs, ounces, pounds, quarts, pecks, etc., all you would have to remember are milli, centi, and kilo:

milli	stands for	1/1000	of a certain quantity
centi	"	1/100	"
kilo	"	1000 times	"

ACTIVITY II-2-3
- 2 -

You probably recall the prefixes for larger and smaller units used in the Metric system in the information on Scientific Notation. Can you remember what MEGA (as in megacycle) represented?

In order to make it even easier for you to remember the prefixes, it may help to think of the meter as one dollar:

If 1 dollar represents 1 meter

then, just as

100 cents = 1 dollar	100 centimeters = 1 meter
1 cent = 1/100 of a dollar	1 centimeter = 1/100 of a meter
10 mills = 1 cent	10 millimeters = 1 centimeter

As you can see, our currency is easy to use because it is based on tens, just like the Metric system.

Obtain a ruler that has both systems on it. Note on the Metric side that each centimeter is divided into ten millimeters. Two centimeters + 5 millimeters would be written as 2.5 cm since the 5 millimeters (mm) are tenths of a centimeter (cm). Into how many parts is the inch divided? How many inches does 2.5 cm represent?

You will need the ruler for the rest of the activities so keep it as you on to Activity 2.

ACTIVITY II-2-4

A

B

ACTIVITY II-2
ANSWER SHEET

2. Rectangle A: 15 in^2 (3" X 5")

96.2 cm^2 (12.7 cm X 7.6 cm)

Rectangle B: 17 151/256 in^2 (4 15/16 X 3 9/16)

114.7 cm^2 (12.6 X 9.1)

3. 61 21/64 in^2 (9 7/16) (6½)

396 cm^2 (16.5) (24)

4. 6.3 cm^2

1.02 in^2

5.

In	Ft	Yd
1	1/12	1/36
3	1/4	1/12
26	2 1/6	13/18
8	2/3	2/9
10	5/6	5/18
4280	356 2/3	118 8/9

mm	cm	m
1	.1	.001
3	.3	.003
26	2.6	.026
8	.8	.008
10	1	.01
4280	428	4.28

ACTIVITY II-3-6
CONSTRUCTING A PROFILE GRAPH

When we look at the earth around us, it is difficult to list what we see for many of the features may be hidden out of sight. A better way to see the earth is to get up above it. Then items hidden before, become clearly visible. You get a much better picture of the earth when you are in a plane than when you are walking. Maps for viewing features seen on the earth's surface, as if they were seen from a plane, are called "Topographic Maps." However, they can also be made right from the surface with "contours."

The way the land surface appears is called its topography. The method used to represent topography, or the shape of the surface, on paper is called contour mapping. Contour lines give us the elevation so that we can visualize the way the land changes from area to area and the high and low points in the landscape.

Generally speaking, the closer together the contour lines, the steeper the object. The number on the contour line gives the elevation. Closed contour lines indicate hills and peaks except where there are "hachure" lines IIIIII which indicate a depression.

However, there are times when viewing from above gives the wrong impression. For example, volcanoes and craters look roughly circular and flat when, in fact, they may be cone-shaped and quite high. Craters may look shallow when, in fact, they may be quite deep. In order to better understand these features, a profile or cross section of these features may be more helpful.

CONSTRUCTING A PROFILE GRAPH

- 2 -

In order to get a more informative view of the crater Copernicus, you will construct a "profile" graph. Using a piece of paper, place an edge of the paper along the floor of the crater. Now mark the crater floor, the top of the rim, and the outer edge of the rim. (When transferred to graph paper, this line will become the horizontal or X axis of your graph.)

Draw your X axis on the graph. Place the piece of paper bearing the crater marks on the axis line and mark them off on the axis.

In order to figure out the value of the lines on the X axis, you will need to know that the distance between the longitude lines on the map (page 12 of Investigation Book #8) is 60 km. What you want to find out now is how many km does 1 cm represent. Measure the distance between the longitude lines in cm. If that measurement represents 60 km, then how many km does 1 cm represent?

Set up a cm scale on the X axis from which you can then read the km measurement by multiplying the number of cm by the value of km equivalent to 1 cm. Now write in the appropriate km for the diameter of the floor of the crater, the diameter of the crater at the top of the rim, and the diameter of the crater at the outside edge of the rim.

You are now ready to put in the Y axis, or the elevation in km. Since you have already set up a scale for the X axis, you should use the same scale for the Y axis in order to get a truer profile of the crater.

ACTIVITY II-3-6
CONSTRUCTING A PROFILE GRAPH
- 3 -

You will now need to read the "contour" lines in order to get the elevation for each of the points on the horizontal axis. You will need to know that the distance between contour lines is .3 km or 300 m. Looking at the contour lines of the crater, estimate the height of the following features:

The edge of the rim outside the crater

The rim at the top of the crater

The crater floor

Central peaks

As you determine the elevation for each of these points, plot them into the graph.

When you have completed the graph, connect the points with lines. You will find that you have drawn a "profile" of the shape of the crater which was not visible from ooking from the top.

Before you hand in your graph, you will find the following information helpful in interpreting your results:

ADDITIONAL INFORMATION:

1. Obtain and view the filmstrip, MEASURING THE SHAPE OF THE LAND. Using the recording to explain the frames.

After you have viewed the filmstrip, try the following:

Drape a cloth over some assorted books, purses, etc., to form a simulated hill. Set the filmstrip projector about half as high as the "hill". Project Frame #60 on the "hill." Make observations about the contour lines from all sides as well as from above. Make a drawing of what you see. Determine the contour level. What happens to the contour lines where the "hill" is steeper?

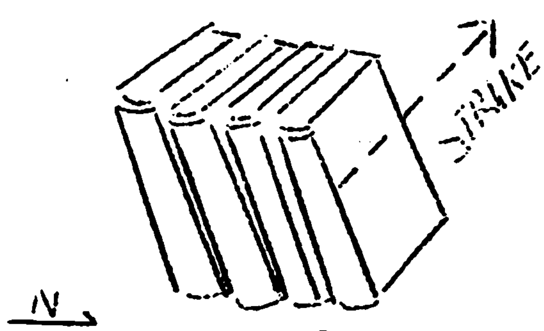
ACTIVITY II-3-6
CONSTRUCTING A PROFILE GRAPH
- 4 -

2. Obtain the filmstrip, MAKING A GEOLOGIC MAP, and listen to the recording while watching the frames. This film shows a special kind of contour map in which not only the shape of the land is shown but also the types of rocks involved. A contour map with rock information is called a "geologic map."

As you have probably observed by now, contour maps of the moon's surface have been made for a great many areas. During the Apollo 15 stay on the moon, Commander Scott was intensely interested in the rock formations he saw. Apollo 17 plans call for the inclusion of a geologist-astronaut on this last U.S. mission to the moon. Why do you think a professional geologist was included to make this trip?

3. Imagine a bookshelf with books lined up as shown below:

Using a compass to determine the strike (the direction) and a clinometer to determine dip (angle of inclination) make a map of the books as they slant on the shelf showing strike and dip.



ACTIVITY II-3-6
CONSTRUCTING A PROFILE GRAPH

4. Obtain and view filmstrip, UNDERSTANDING TOPOGRAPHIC MAPS. Note observations in your notebook.

5. Read pp. 131-137 in MODERN EARTH SCIENCE. Make notes in your notebook of the topographic maps shown. Read pp. 230-231 and make note of the diagrams including the symbols used for rock types.

6. Make a topographic map using a relief model of the landform to be contoured, a plastic box, a grease pencil. Mark the box with equal intervals (2.5 cm for example) to represent contour intervals. Cover the box and, viewing from above, trace the outline on the cover as water is added to the various levels marked on the outside of the box. Copy the topographic map made into your notebook.

7. Obtain TOPOGRAPHIC MAPS FOR EARTH SCIENCE. Read and answer as many questions as you can for:

   Map Exercise #1: READING A MAP
   #2: PROFILES AND GRADIENTS
   #23: VOLCANICS I
   #24: VOLCANICS II

8. Obtain a stereo viewer and a copy of the STEREO ATLAS. View the scene of various land forms as though you were flying over them. Compare the topographic map with the view you observed.

9. Obtain STEREOSCOPIC AERIAL PHOTOGRAPHS FOR EARTH SCIENCE. Note particularly Plates 28-31. Draw the topographic diagrams in your notebook.

EXPERIMENT III-1-1
Space Exploration For Benefit of Earth
RADIATION

I. PROBLEM: Can radiation be measured?

II. EQUIPMENT: Geiger Counter
Rock Specimens

III. PROCEDURE:

A. Set the instrument panel as indicated on the particular Geiger Counter used.

B. Determine any background radiation that may be caused by radioactive materials on the earth or by cosmic rays from outer space. Move the counter to various places about the room. Record your findings.

C. Obtain samples of radioactive materials. Place one at a time at the proper "window" or area for radiation detection. Record your findings by naming the material and the number of "ticks" per minute.

IV: OBSERVATION:

A. Record the Geiger Counter setting used.

B. Background radiation chart:

AREA TESTED	CLICKS/MINUTE	READING

C. Radioactive materials:

NAME OF MATERIAL	CLICK/MINUTE	READING

V. RESULTS:

A. Briefly explain how a Geiger Counter works to detect radiation. (See pages 441-2 in MODERN PHYSICAL SCIENCE, page 169 in MODERN EARTH SCIENCE, and other sources you can find.)

B. Of what significance is the background radiation?

C. Summarize your findings. Answer the question posed in the problem.

ACTIVITY III-1-2
SUN'S RADIANT ENERGY: SPECTROSCOPE

PLEASE HAND IN A CARBON COPY. KEEP THE ORIGINAL. BE SURE YOUR NAME AND HOMEROOM IDENTIFY YOUR EXPERIMENT.

I. PROBLEM: Identification of radiant energy by different colors of light representing different wavelengths.

II. MATERIALS:
- Wire loop
- HCl
- Bunsen Burner
- Spectroscope
- Salts (NaCl, $CuSo_4$)
- Hydrogen lamp
- Fluorescent lamp

III. PROCEDURE:

1. Clean the end of the wire loop by dipping it in HCl and holding the loop in the flame of the Bunsen Burner until no color is evident.

2. Dip the loop into the substances to be observed, placing in the hottest part of the flame.

3. Observe the predominent color of the flame produced.

4. Repeat step #3 but using the spectroscope to view the flame. Note your observations on a spectrum chart.

5. View sunlight with the spectroscope and note your observations. DO NOT LOOK INTO THE SUN. Looking outside is sufficient.

6. View a fluorescent lamp - probably the lighting in your class room is with fluorescent lighting. Note your observations.

7. View a hydrogen lamp (or other that may be available). Note your observations.

IV: OBSERVATIONS:

Complete spectrum charts, identifying the source of radiation and the Angstrom involved.

V. RESULTS:

Explain in your own words the meaning of what you have observed.

ACTIVITY III-1-5
RADIANT ENERGY

I. PROBLEM: In determining radiant energy, does temperature change relate to the distance from the source?

II. EQUIPMENT:

See 7.1 on page 156 in INVESTIGATING THE EARTH.

III. PROCEDURE:

See 7.1 on page 156 in INVESTIGATING THE EARTH

IV: OBSERVATION:

1. Arrange your data in the form of a chart:

	STARTING T (BT)	FINAL T (ST)	T CHANGE (OTC)	DISTANCE cm
#1				
#2				
#3				
#4				

2. Obtain graph paper and plot your data, making the X axis the distance from the light and the Y axis the temperature change.

   Indicate by different colored pencils (or other method) the four objects used.

V. RESULTS:

Answer the questions on page 157.

ACTIVITY III-1-5 B
MEASUREMENT OF ENERGY RECEIVED FROM THE SUN

I. PROBLEM: How many calories of heat do we receive from the sun?

II. EQUIPMENT: Laboratory flask or bottle
Rubber stopper to fit the top of flask or bottle
Centigrade thermometer, fitting the stopper
Black paper to cover the flask
Water (at room temperature)
Balance
Clock or watch

III. PROCEDURE:

A. Review the meaning of "calorie" by reading pp.123-3 in EARTH SCIENCE (Silver Burdett).

B. Determine the mass (amount) of water you will be using:

1. Find the mass of the flask or bottle
2. Fill the vessel about two-thirds full with water
3. Find the mass of the vessel plus the water
4. Determine the mass of the water

C. Place the vessel in direct sunlight, after having recorded the temperature of the water at the start of the activity.

D. After an interval of 10 minutes, read and record the temperature of the water again.

E. Determine the change in temperature.

F. Repeat D and E after another interval of 10 minutes.

G. Calculate the number of calories of heat absorbed by the water (received from the sun) in 20 minutes. From this figure out calories per minute. (cal = mass of water X change in temperature)

IV: OBSERVATION:
Record your findings in the form of a chart.

V. RESULT:

A. Define the meaning of calorie.

B. Give your estimate of the calories we receive from the sun per minute.

C. In your previous readings, mention was made of energy from the sun in terms of square centimeters. How would you go about determining the energy of the sun per square centimeter?

ACTIVITY III-1-11
SPACE EXPLORATION FOR BENEFIT OF EARTH
Do Sunspots Affect the Weather?

I. PROBLEM: Is there a relationship between sunspot activity and the weather?

II. EQUIPMENT: Annual Sunspot Numbers from 1750 to 1964
Average Summer Temperatures for New Haven, Conn. from 1780 to 1960
Graph paper

III. PROCEDURE:

A. Plot the sunspot data, making "year" the X axis and "sunspot number" the Y axis.

B. Plot the New Haven temperatures on the same graph. The X axis is the same for both the sunspot number graph and the temperature chart. Next to the "sunspot number" on the Y axis parallel the temperatures.

C. Join the points of each of the two graphs with different colors or other designation.

IV: OBSERVATION:

List any correlation you note between sunspot number and temperature.

V. RESULTS:

A. Over long periods of time, average temperatures seem to become warmer or cooler. What did you observe in your graphs which might prove or disprove this?

B. What relationship is there between temperature and weather?

C. What relationship did you note between sunspot activity and temperature?

D. Do you think there may be a relationship between sunspot activity and weather?

E. Do you think that the results would have been different if the temperature data were taken from some other place than New Haven? Why?

ACTIVITY III-1-11

SPACE EXPLORATION FOR BENEFIT OF EARTH

Do Sunspots Affect the Weather?

AVERAGE SUMMER TEMPERATURES

New Haven, Connecticut

PLEASE NOTE: The temperatures as given are Fahrenheit degrees. BEFORE PREPARING THE GRAPH, CONVERT TO CELCIUS (CENTIGRADE) DEGREES

YEAR	FAHRENHEIT	CELCIUS
1780	70.3°	. . . .
1790	70.3	. . . .
1800	70.2	. . . .
1810	70.2	. . . .
1820	68.2	. . . .
1830	69.6	. . . .
1840	68.8	. . . .
1850	70.0	. . . .
1860	68.2	. . . .
1870	69.9	. . . .
1880	71.0	. . . .
1890	68.4	. . . .
1900	69.0	. . . .
1910	68.7	. . . .
1920	69.2	. . . .
1930	69.7	. . . .
1940	71.3	. . . .
1950	70.2	. . . .
1960	70.0	. . . .

ACTIVITY III-1-11
SPACE EXPLORATION FOR BENEFIT OF EARTH
Do Sunspots Affect the Weather?

ANNUAL SUNSPOT NUMBERS

Yr	SUNSPOTS	YR	SUNSPOTS	YR	SUNSPOTS	YR	SUNSPOTS
1750	83	1797	6	1844	15	1891	35
51	47	98	4	45	40	92	72
52	47	99	6	46	61	93	84
53	30	1800	14	47	98	94	78
54	12	01	34	48	124	95	64
55	9	02	45	49	95	96	41
56	10	03	43	50	66	97	26
57	32	04	47	51	64	98	26
58	47	05	42	52	54	99	12
59	54	06	28	53	39	1900	9
60	62	07	10	54	20	01	2
61	85	08	8	55	6	02	5
62	61	09	2	56	4	03	24
63	45	10	0	57	22	04	42
64	36	11	1	58	54	05	63
65	20	12	5	59	93	06	53
66	11	13	12	60	95	07	62
67	37	14	13	61	77	08	48
68	69	15	35	62	59	09	43
69	106	16	45	63	44	10	18
70	100	17	41	64	47	11	5
71	81	18	30	65	30	12	3
72	66	19	23	66	16	13	1
73	34	20	15	67	7	14	9
74	30	21	6	68	37	15	47
75	7	22	4	69	73	16	57
76	19	23	1	70	139	17	103
77	92	24	8	71	111	18	80
78	154	25	16	72	101	19	63
79	125	26	36	73	66	20	37
80	84	27	49	74	44	21	26
81	68	28	62	75	17	22	14
82	38	29	67	76	11	23	5
83	22	30	71	77	12	24	16
84	10	31	47	78	3	25	44
85	24	32	27	79	6	26	63
86	82	33	8	80	32	27	69
87	32	34	13	81	54	28	77
88	30	35	56	82	59	29	65
89	18	36	121	83	63	30	35
90	89	37	138	84	63	31	21
91	86	38	103	85	52	32	11
92	60	39	85	86	25	33	6
93	46	40	63	87	13	34	8
94	41	41	36	88	6	35	36
95	21	42	24	89	6	36	79
96	16	43	10	90	7	37	114*

*USE PREVIOUS CHART FOR CONTINUATION

ACTIVITY IV-1-2
INTRODUCTION TO METRIC SYSTEM: MASS

One of the most important concepts of matter in the modern age is that of mass. It is especially important since we have started space exploration.

Mass in science refers to the quantity of matter - how much there is of a substance. This is quite different from how much it weighs. A given quantity of matter will remain the same if nothing is done to remove any part of it but its weight will change depending on how the force of gravity acts upon it. The greater the pull of gravity, the greater the weight; the weaker the pull of gravity, the smaller the weight. Mass, then, is the amount of matter in a substance while weight is the degree to which gravity is pulling on the given amount. An astronaut, weighing on Earth about 160 pounds, will in deep outer space weigh zero while, on the moon, about one-sixth his Earth weight. However, whether in space or on the moon, the amount of matter of which he is made remains the same although his weight varies with the gravitational environment. Mass is constant while weight changes.

Working with a factor that would constantly change would be complicated and inaccurate to say the least. For that reason, science uses the concept of mass. How can we overcome the force of gravity on Earth (or anywhere) in making mass measurements? Isn't gravity constantly pulling on the amount of matter we are measuring? To overcome this problem, science makes use of the equal arm balance which measures the unknown quantity of matter against a known quantity set up as a standard. Balancing one against the other cancels the effect of gravity.

The standard used is the gram. Undoubtedly some other intelligence on some other planet has its own standard but, should we ever meet, comparisons could be made and a conversion system made. It, therefore, really makes no difference what standard is used - stones, beads, grain or whatever, AS LONG AS EVERYONE ELSE USES THE SAME UNIT.

How this standard, the gram, came to be universally adopted on the planet Earth will be discussed later.

In order to better understand how mass and weight are used, mass for the Metric System and weight for the English, in your notebook prepare two tables as given below and complete the information missing:

OZ.	LB.
16	1
8	
4	
1	
½	
1/5	

gm	kgm
16	.016
8	
4	
1	
.5	
.2	

Remember that 1 lb. will weigh zero lb. in space while a mass of 16 gm will be 16 gm in space or anywhere.

ACTIVITY IV-1-4
HOW MAY MASS BE DETERMINED?
Equal Arm Balance

I. PROBLEM: Determination of mass of two samples of minerals by use of commonplace units, such as, beans or beads.

II. EQUIPMENT: Balance (constructed by student)
Weight units available
Two minerals (Tag these with your name for future use)

III: PROCEDURE:

A. After obtaining the two samples of minerals make the following observations:
1. How do these specimens compare in size?
2. If these specimens are compared by holding one in each hand, what other characteristics do you observe?
3. Using the equipment supplied you for weight units, or using any of your choice, try to figure out a system by which you could determine the comparative masses of the two objects.
4. Record the masses of the two specimens using the system of measurement you have devised.
5. Compare your system to that of your neighbor. Could you make an even exchange?

B. Obtain a one-gram weight and determine how many units of your system equal 1 gram.

C. Can you now make an even exchange with your neighbor?

IV. OBSERVATION:

SPECIMEN	MASS IN STUDENT UNITS	MASS IN GRAMS

Check with standard laboratory balance . . . .

Amount of difference observed . . . .

V. RESULTS:
1. Size comparison by observation:
2. Comparison by handling:
3. Student system used:
Include limitations of your system
4. Student conversion table: 1 gm = ...
5. Mass of samples in student units: . . . .
in standard . . . .

ACTIVITY IV-1-5
HOW MAY MASS BE DETERMINED?
Unequal Arm Balance

I. PROBLEM: Determination of mass of two samples of minerals by use of unequal arm balance.

II. EQUIPMENT: Balance (constructed by student)
Two minerals (used in IV-1-4) + string
10 gm weight + string

III: PROCEDURE:

A. Observe that the balance, without the cup buckets, acts like a "seesaw." Hang one specimen on one arm and the 10-gm weight on the other. Adjust until the entire arm balances.

B. Note that the arm is divided into 30 units on each side of the center pin (0). These are the distance units in centimeters. What is the total length of the balance arm? What is the equivalent in the English system?

C. Note the reading in centimeters where the 10-gm weight on one side and the specimen on the other side were placed to make the "seesaw" balance.

D. Move the gm-weight and the specimen to different places on the balance arm, each time, however, making sure that they balance. Record your findings in a chart.

E. You are probably aware by this time that, in order for the arm to balance, the objects hanging down must be changed in distance from the center as you change their position. In other words, one side must equal the other side if the "seesaw" is to balance.

Using the figures in your chart, multiply the mass of the object on one side (10 gm) by the distance. Do the same for the mass on the other side (you already know the mass since you determined this in Activity IV-1-4). What do you notice about the answers?

IV: OBSERVATION:

10 gm TIMES cm (distance) = X gm (specimen) TIMES cm

( ) X ( ) = ( ) X ( )

ACTIVITY IV-1-5
HOW MAY MASS BE DETERMINED?
Unequal Arm Balance

V. RESULTS:

A. Total length of balance arm: . . . . . (cm) . . . . (in)

B. The product of the mass X distance on one and the product of the mass X distance on the other side are . . . .

C. Using "M" for mass and "D" for distance, rewrite the above sentence as a mathematical equation:

D. Using the equation, designate your specimen as the unknown factor in the equation.

E. Determine the mass of the specimen. Does it check with the results you found in the previous Activity?

F. Using the formula, determine the mass of an unknown specimen. Check your results on the standard laboratory balance.

G. Trade specimens with another student and, as a check for each other, again determine the mass of the unknown.

INTRODUCTION TO METRIC SYSTEM
VOLUME

In a previous activity, you learned how to make linear measurements in the Metric System, using the centimeter as your fundamental unit. More recently you found that you could find the mass of objects (how much matter), using the gram as the fundamental unit. In order to complete your skill in measurement, you also need to know how much space objects may occupy. This taking up of space is called "volume" and, in the English system, you are probably familiar with the word "cubic" such as, cubic feet or cubic yards. In the Metric System, the unit of volume is the cubic centimeter. The same ease of working with numbers applies to volume as it did to learning linear measurements.

If you wish to obtain the volume of a regular object, such as, a book, you can use a ruler to get the three measurements needed: length, width, and height. For example, if you find that an object is 2 cm X 7 cm X 3 cm, then by multiplying length times width times height will give you 42 cm^3.

Another regular object you might wish to measure for volume is a penny which is really a cylinder having a certain height and circular base. The formula for volume of a cylinder is $\pi r^2 h$.

The volume of a sphere, such as, the earth or a styrofoam ball, would be $4/3 \pi r^3$.

So far, you may have noticed that the objects were fairly easy to calculate for volume either by direct measurement or by measurement and derived formula. What happens, however, if you have to measure the volume of an irregular object, such as, a rock or a nail?

It would take too long a time and probably would not be accurate anyway if you had to use a ruler. The Metric System gives us an easy, practical method to do this difficult job. It is called "water displacement." You probably have experienced water displacement - when you stepped into the bathtub! The water you had run into the tub reached a certain height when you shut off the water coming from the faucet. When you stepped into the tub, did you ever notice how the water rose? What caused it to rise? Of course, you did. Since two bodies of matter cannot occupy the same space at the same time, either the water molecules or you had to give way. Since you are a solid compared to the water which is a liquid, the water molecules had to give way for you and the molecules displaced by you had to go some where so you saw the water level rise.

By how much did the water level rise? By the amount of space you occupied. You displaced the water molecules by the amount of space that you took up. Could you measure how much space you took up? You have probably guessed that the amount was equal to the amount of rise in the water level. In other words, the difference in the water levels was equal to your volume.

Instead of using a bathtub to measure irregular objects, scientists use a very handy tool called the "graduated cylinder." The "graduated" refers to the markings on the cylinder. If you look at a graduated cylinder you may notice that it is marked in units of ten, just like the Metric ruler. However, since these units deal with a liquid and, therefore, volume - the unit of measure is the milli<u>l</u>iter instead of milli<u>m</u>eter as you noticed in using the ruler. Abbreviated it would be ml instead of mm. However, since ml and cm^3 both are units of volume, these may be used interchangeably. Why this is so will be explained later.

Please note: In using a graduated cylinder, you may observe that the liquid contained therein is not flat but curved. The proper way to read the liquid is to hold the area at eye level. This curve is called the "meniscus." The lowest part of the miniscus is the correct reading, provided the liquid wets the cylinder. In the case of mercury, however, which is a metal but in liquid form at room temperature, the cylinder remains dry and the correct reading is taken at the top of the meniscus.

It may happen, however, that a graduated cylinder may not be available. There is another method for obtaining the volume of irregular objects which uses the same idea but in a different way. It is based on the "apparent loss of weight in water." You have probably noticed that in water you seem to be much lighter than on land - that is, you seem to have lost weight in water and may even float as though gravity were not pulling on you anymore. You know that you have not suddenly lost weight but it feels like it - there is an "apparent" loss of weight but not real loss.

INTRODUCTION TO METRIC SYSTEM

VOLUME

Archimedes, a Greek philosopher and scientist, is believed to have been the first to discover how objects behave in water and what effect water has on objects placed in it. In fact, it is said that it was he who first thought about all of this, including the bathtub description above, while searching for an answer to a difficult problem. As was the custom of the day, the baths were used for places of repose and thought. Archimedes was faced with the problem of whether or not a gift of a crown to the king was really gold or a hoax. It was while he was pondering this that he suddenly realized that each body of matter would displace its own volume and that, if he could find the volume displaced by gold, he could then find out if the crown were gold. It is said that with this sudden insight he leaped up and cried "Eureka!" which might be interpreted as "I found it" - I have it - and to this day when people suddenly see the flash of understanding they quite often cry, "Eureka!".

What Archimedes discovered about the "apparent loss of weight in water" is called the Principle of Archimedes: when an object is placed in a fluid, such as water, it is pushed up (buoyed up) by a force which is equal to the weight of the displaced fluid or water. This displacing simply refers to the pushing aside of the liquid molecules. If you sit in a tub of water, you push the water molecules aside. The volume of the water pushed aside must be equal to the amount of space (volume) taken up by the rock. In addition, just as as you feel lighter in water, the rock apparently seems lighter. This is explained by the idea that the molecules of water are pushing in all directions, including upward. You and the rock seemed to have lost weight because some of the molecules are pushing upward or producing a "buoyant" effect. If you could weigh yourself in the water, you would actually see a loss in weight although you would know that this is not real. The difference between what you weigh on land what you weigh in water would be the "apparent loss of weight in water." The same is true of the rock - the difference between what it weighs in air and what it weighs in water is the "apparent loss of weight in water." As you will find later, this apparent loss of weight in water is also its volume. As you will find out, the Metric System measurements are based on a cube that is 1000 cm^3 in linear units. It was stipulated that this 1000 cm^3 cube would hold 1000 ml of water and have a mass of 1000 gm. Therefore, if a 1000 cm^3 cube holds 1000 ml of water and has a mass of 1000 gm, then 1cm^3 cube would be the equivalent of 1 ml of water and have a mass of 1 gm. The apparent loss of weight in water of a rock having a mass of 10 gm in air might be 2 gm, giving the illusion that the rock has a mass of 8gm. This 2 gm would be the equivalent of 2 cm^3 of volume pushed aside by the rock and, thereby, would represent the volume of the rock.

An interesting question might be, suppose this rock were taken to the moon, or even into outer space. Would you use mass or weight to your calculations? Why? When we use an equal arm balance on earth, can we interchange mass and weight?

VOLUME OF AN IRREGULAR OBJECT

I. PROBLEM: Determine the volume of the two specimens used in Activities IV-1-4 and IV-1-5.

II. EQUIPMENT: Unequal arm balance
Graduated cylinder
10 gm weight
Two mineral specimens used previously + string
Transparent container + water

III. PROCEDURE:

A. Prepare the balance as you did for finding the mass. (If you have not already found the mass of the specimen, do so at this time.)

B. Submerge the specimen (tied to a string) into the container of water.

C. Determine the mass of the specimen now submerged.

D. Subtract the submerged weight from the mass in air. What does this represent?

E. Do the same for the second specimen.

F. Check your findings with a graduated cylinder and record the result, noting any difference.

IV. OBSERVATION:

Show all the work involved in determining the volume of the two specimens.

V. RESULTS:

A. Volume of specimen 1 . . . .

B. Volume of specimen 2 . . . .

C. Results of check with graduated cylinder . . . .

. . . .

D. Briefly explain how what you found represents volume.

ACTIVITY IV-1-9
INTRODUCTION TO METRIC SYSTEM: HISTORY AND MODERN DEVELOPMENT OF MEASUREMENT

Mankind has always had a need to make measurements. How did we in the United States, come to use the British or English system rather than the Metric? As the name itself implies, it was imposed on us when were colonies of England. Because we have become accustomed to this system, it seems easy to us but a look into its beginnings and accuracy have made us aware, in this modern age, that it might be to our advantage to make a change to a system now being used universally. Even England itself has now gone on the Metric system.

Britain was (and still is) a form of monarchy. Tradition gave royalty undue powers and obedience. When man began to need to make more accurante measurements, the monarchy decided that 3 barley corns should equal an inch; that its royal foot should equal "one foot"; that the standard yard would be the length from its royal nose to its outstretched arm; that a rod would equal the length required to hold the royal attendants; etc. Of course, since royalty's measurements were not all the same, the measurements from court to court would vary with the shoe size or arm length! This, then, was the precise mode of measurement which we inherited.

There was one saving grace, however. When we declared our independence, our forefathers had the good sense to make our monetary system based on tens, like the Metric system.

In the meantime, other nations around the world realized the need for an international standard and, in 1792, soon after the

ACTIVITY IV-1-9
INTRODUCTION TO METRIC SYSTEM:
HISTORY AND MODERN DEVELOPMENT OF MEASUREMENT
- 2 -

French revolution, French scientists met and determined a standard measurement for the meter, based on measuring one ten-millionth of the distance from the equator to the North Pole on the meridian that passes through Paris. A platinum bar measuring this distance was then used as the standard meter. In 1875, a meter stick, based on the bar adopted as the standard meter, was placed at the International Bureau of Weights and Measures at Sevres, France. This was still not a very precise instrument of measurement since expansion and contraction of metals did make changes in the length and no one could be absolutely sure about the accuracy of one ten-millionths of the distance from the equator to the North Pole on the meridian that passed through Paris but it was certainly more accurate than barley corns or a king's foot.

In 1960, a standard was used that could be duplicated in every laboratory around the world - the wavelength of the orange light from a Krypton isotope (an element of Krypton having the same atomic number but different atomic mass). The wavelength is given as 1,650,763.73Å or 1.65 X 10^6 Å. The Å stands for "angstroms" and is a unit of measuring wavelengths and other dimensions too small for our normal purposes. One angstrom is equal to 1 X 10^{-8} cm. Since wavelengths are a characteristic property of what is called the "Electromagnetic Spectrum" (see the chart on page 143 in TERMS, TABLES, AND SKILLS), this would not be affected by heat or cold or other physical factors which could alter measurements of metals.

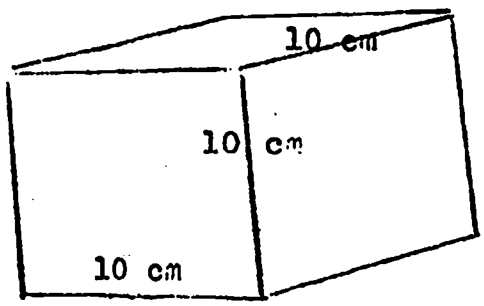
ACTIVITY IV-1-9
INTRODUCTION TO METRIC SYSTEM:
HISTORY AND MODERN DEVELOPMENT OF MEASUREMENT
- 3 -

In 1964, the 12th General Conference on Weights and Measures defined the liter as a volume exactly equal to the cubic decimeter or 1000 cm^3. In order to save time and space, instead of using cm^3 this has been shortened to cc. (cubic centimeter). Since milliliter is the unit for volume of liquids but is still volume, today cc and ml are used interchangeably inasmuch as cc also stands for volume. Laboratory apparatus is usually marked "ml" although one may see cc on some.

It was further decided that the mass of water (at is greatest density) filling the volume would equal 1000 grms or gm. Please note that gram is abbreviated to "gm" in the modern use since "g" - the older use - may now be confused with our space use of gravity as small "g".

In summary, then:

1. The meter is based on wavelength of Krypton
2. The volume is based on one cubic decimeter (which, in turn, is based on the meter). One decimeter = 10 cm.
3. The mass of water (at its greatest density) filling the volume is 1000 gm (1kgm)



= 1000 cubic centimeters
1000 cc (cm^3) (linear)
1000 cc holds 1000 ml (vol)
1000 ml has mass of 1000 gm

THEREFORE: if 1000 cm^3 is the equivalent of 1000 ml which is 1000 gm
then 1 cm^3 " 1 ml " 1 gm

If we add one other fundamental unit to the centimeter-gram, that is, TIME, we have the fundamental units of the CGS Metric system: centimeter-gram-second. These three-standing for length, mass, and time-are considered the fundamental units of measurement. All other units are combinations of these three. It is interesting to note that time is also standardized on the vibrations of the Cesium atom and work is now in progress to further the accuracy of time by use of the Hydrogen atom.

For some scientific work it may be more convenient to use 1000 cm and 1000 gm instead of 1 cm and 1 gm. This becomes known as the MKS Metric system: meter-kilogram-second. (The English system, as you probably have guessed by now, is called the "Foot-Pound-Second" system of FPS.

A year after the Civil War, Congress had before it a bill to change our English system to the Metric. More than a hundred years have gone by with nothing done. Very recently, the bill was once more brought before Congress for consideration. If you were a member of Congress, how would you vote?

The Metric system is now being used in the design of rockets. For example, the "Maverick" is the first U.S. missile to be completely designed on the Metric system. Model rocketry has now converted to the Metric. Of course, science classes use the Metric system because of the need for greater accuracy and desire to eliminate time wasted in doing mathematical problems in the English. It has been estimated from the experience of other countries that it takes approximately two generations to make a complete conversion to the Metric. How long do you think it will take us?

SIGNIFICANCE AND MEASUREMENT OF DENSITY

In your previous activities you learned how to find the mass and volume of regular and irregular objects. Mass and volume are important in science since they help us to identify of what substances are made without taking them apart through a relationship between mass and volume called "density." This relationship is written as a formula:

$$\text{Density} = \frac{\text{Mass (gm)}}{\text{Volume (cm}^3\text{)}} \qquad \text{or} \quad D = \frac{M}{V}\ \text{gm/cm}^3$$

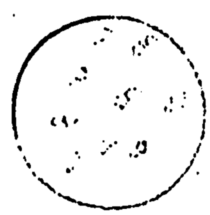
Density depends on mass (how much matter there is without regard to gravity) and on volume (how much space this matter occupies). Density helps to identify substances because each form of matter making up the substance has its own atomic structure. The number and arrangement of atoms and molecules that fit into a given space is different for different substances, even if the kind of atom is the same. For example, carbon makes up both coal and diamonds but would you say they are the same substance? If not, what makes the difference even though they both are made of carbon?

The big difference lies in the arrangement of the atoms. The carbon atoms are tightly packed in a diamond while in coal they are not. We say that the diamond is denser than coal. Using a standard amount of space, 1 cm^3, there are more carbon atoms in diamond than in coal because of the way the atoms are arranged. This same idea is true of different kinds if atoms. For example, 1 cm^3 of feather atoms (atoms which go to make up a substance called feathers) would be more loosely packed than 1 cm^3 of atoms making up a substance called aluminum. The aluminum substance would then be said to have greater density than the feather substance.

Generally speaking, solids are more dense than liquids and liquids more dense than gases:

solid

liquid



gas

We use the density of water as the standard since its density equal 1. Why does the density of water equal 1? If density is the ratio of the mass of a substance to a standard volume it occupies, then, in water, the relationship is 1 gm of water to 1 cm^3. (Recall that if 1000 cm^3 has a mass of 1000 gm, then 1 cm^3 of water has a mass of 1 gm. If we write the relationship of mass to volume in the formula, than:

$$D - \frac{M}{V} \text{ or the Density of water} = \frac{1\ gm}{1\ cm^3} = 1\ gm/cm^3$$

If the density of water is 1, then the density of solids is greater than 1 and the density of gases less than 1. Would a rock specimen have a density of 1, greater than 1, or less than 1? Since a rock is a solid, it probably would have a density greater than. (Pumice is an exception, however, since it is a frothy volcanic rock and is so light that it can float.) Suppose a rock smaple had a mass of 10 gm. If its volume were found to be 2 cm^3, then its density would be:

$$D = \frac{M}{V} \qquad D = \frac{10\ gm}{2\ cm^2} = 5\ gm/cm^3$$

In the above determination, the volume of the irregular object was obtained by use of a graduated cylinder. However, if no cylinder is available there is another method to find density involving the same principle but differing in the determination of "volume." It is known as "specific gravity" and, in books on minerology, very often specific gravity is used instead of density. In this case:

$$\text{Specific Gravity} = \frac{\text{Mass of object in air}}{\text{Loss of mass of object in water}}$$

In your activity on volume of irregular objects, you experienced this "lose of mass in water" when you submerged your rock specimen. Actually, this mass loss in water was equivalent to the volume of the specimen by water displacement. Using the above example, if the 10 gm rock was found to have a mass of 8 gm when submerged in water, then its mass loss would be 2 gm. Finding its specific gravity would look like this:

$$S.G. - \frac{\text{Mass in air}}{\text{Mass loss in water}} = \frac{10\ gm}{2\ gm} = 5$$

Compare this to the:

$$D = \frac{\text{Mass}}{\text{Volume}} = \frac{10\ gm}{2\ cm^3} = 5\ gm/cm^3$$

ACTIVITY IV-1-10
SIGNIFICANCE AND MEASUREMENT OF DENSITY
- 3 -

You can see that the specific gravity would be "5" since the units (gm) cancel out while the density would be 5 gm/cm^3 since the units (gm and cm^3) do not cancel out. Specific gravity and density refer to the same characteristic although the method of determining each differs, density using linear measurement or graduated cylinder for volume calculation while specific gravity uses water displacement without use of a graduated cylinder. You should be aware of both methods.

In order to practice and improve your skill in understanding and determination of density, perform:

ACTIVITY IV-1-10: DENSITY AND SPECIFIC GRAVITY OF UNKNOWN IRREGULAR OBJECTS, using the two rock specimens kept from the activity on mass and on volume determination.

EXTRA: ACTIVITY IV-1-10_B: DENSITY OF GEOMETRIC SOLIDS

ACTIVITY IV-1-10_S: DENSITY OF UNKNOWN FLUIDS

ACTIVITY IV-1-10_D: DENSITY OF ICE

DENSITY AND SPECIFIC GRAVITY OF UNKNOWN IRREGULAR OBJECTS

I. PROBLEM: To determine the density and specific gravity of objects A. and B.

II. EQUIPMENT: Unequal arm balance
Container of Water
Specimens A and B
Graduated cylinder
10 gm weight

III. PROCEDURE:

A. To determine density: and specific gravity:

	A.	B.
1. Find the mass of the objects:		
Unequal arm method:		
Check with lab balance:		
2. Find the volume of the objects:		
Graduated cylinder:		
Mass loss in water:		

B. Formula to be used:

1. $D = \frac{M}{V}$

2. $S.G. = \frac{\text{Mass in air}}{\text{Mass loss in water}}$

IV: OBSERVATIONS:

Arrange the data obtained above in chart form.

V. RESULTS:

1. Density of object A ____________________

'. B ____________________

2. Specific Gravity of object A ____________________

B ____________________

3. Explain the difference and similarity between results obtained.

DIMENSIONS OF THE EARTH

I. PROBLEM: To determine the mass, volume, and density of the Earth.

II. EQUIPMENT: Galena
Calcite
Unequal arm balance
10 gm weight

III. PROCEDURE:

A. Determining the mass of the earth:
1. What formula will be used?
2. Rewrite the formula so that mass equals the other factors.
3. What information will be needed before you can proceed?

B. Determining the volume of the earth:
1. What geometric figure does the earth represent?
2. What formula is used to determine the volume of such a figure?
*3. If the radius of the earth is given as 6400 km, what is this in cm?
4. What is your estimate of the volume of the earth?
5. What further information will be needed before you can find the mass of the earth?

C. Determining the density of the earth:
1. What formula will be used?
2. Since the density of the earth is an average of the density of its interior and of its surface, use the two mineral samples to obtain this average. Galena will represent the earth's interior while the calcite will represent the earth's surface:

a. Density of galena (earth's interior)
b. Density of calcite (earth's surface)
c. Estimated average density of the earth

IV: OBSERVATION:
Answer all questions posed in procedure. Show your work.

V: RESULTS:

A. The mass of the earth is estimated to be:
B. The volume of the earth is estimated to be:
C. The density of the earth is estimated to be:

- - - - - - - - - - -

* See Activity IV-1-12 B for determination of radius.

TSM ACTIVITY IV-1-13 B 8th

DETERMINATION OF RADIUS BY USE OF SHADOWS

INSTRUCTIONS: Obtain Investigation Book #5 and answer the following questions on a separate sheet to be handed in.

1. Looking through pages 6-11 in your Book #5, determine what three things affect the length of shadows.

2. Using tracing paper provided you, copy the figures on page 12. Connect the top of the object with the end of the shadow.

3. What is formed in each case?

4. What angles are formed: at the base
   at the top
   at the remaining angle

5. What do you notice about the lines you drew with relationship to each other:

6. What does this tell you about light from the sun?

7. Trace the figure shown on page 13. Draw lines connecting the small holes. Make sure that you connect corresponding pairs.

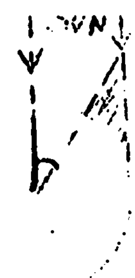
8. How is this related to your answer in question #6?

9. How can the information you have found about shadows help to determine the circumference of the earth?

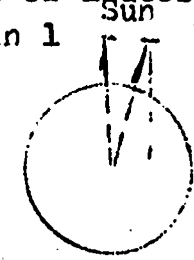
   Eratosthenes used such information to help him determine the circumference of the earth a long time ago - about 200 BC.

10. Using the diagram below and the information given on pages 14 and 15, try to figure out how you might determine the circumference of the earth by the use of shadows.

    Remember that there are 360° in a circle.



11. To check if the method is reliable, obtain a styrofoam ball and two straight pins, simulating the method of Eratosthenes.



EXPERIMENT A: ROCKS

Since we have found out something about the minerals which form rocks and have a better understanding of the fact that rocks are made up of one or more minerals, we might now consider identification of three main types of rocks.

Before proceeding, let us recall that in our discussion of the minerals that make up rocks, we found some ways of telling them apart:

1. Hardness
2. Breakage vs. crystal formation
3. Streak
4. Specific gravity
5. Acid test

What are the ways in which we might be able to differentiate rocks? As we notifed in mineral identification, color was sometimes a helpful characteristic but not always reliable. In rocks, however, color is useful in determining some of the general mineral composition. For example, light colored rocks have more FELSIC minerals than dark colored rocks which have more MAFIC minerals. The felsic minerals include the light colored feldspars (orthoclase, muscovite, albite, and labradorite) while the mafic minerals include the dark colored minerals, such as, augite, hornblende, biotite, and olivine. The felsic minerals are made mainly of oxygen and silicon while the mafic minerals are made mainly of iron and magnesium, although some oxygen, silicon, and other minerals may also be present.

Color in rocks, therefore, is useful for general identification of the main minerals present. However, more information is necessary. For example, the differences in the size, shape, and arrangement of the minerals in the rocks is one way of telling them apart. This is called TEXTURE. The specific minerals of which they are formed might be another clue. The way in which they were formed would be another useful point. For example, igneous rock is made up of minerals which have formed from icnic magma beneath the surface of the earth. Sedimentary rocks are formed from the deposits of weathering and erosion. Metamorphic rocks form from the igneous or sedimentary or some combination of the two but under the tremendous forces of heat and pressure that change the face of the earth.

ACTIVITY:
1. Obtain 3 rock samples, marked A, B, and C.
2. Prepare a chart showing texture, color, minerals present, special characteristics, and type or rock.
3. Write up the data you accumulate into the proper 5-step experiment form.

TEXTURE	COLOR	MINERALS:	SPECIAL:	ROCK

TSM 8th

UNIT: LITHOSPHERE INDENTIFICATION: ROCKS & MINERALS

IV-2-1

EXPERIMENT B: HARDNESS

Identifying minerals is something like being a special agent in search of clues. Since you cannot carry all your tools with you, it becomes important to limit yourself to a few which will help to identify the main type of mineral and then, in the laboratory or with the help of an experienced person, make more detailed tests.

WHAT SIMPLE TOOLS CAN WE USE?

For most practical purposes, hardness may be determined by scratching with your fingernail (hardness 1-2½) or with a copper coin (hardness 3).

Minerals that can scratch glass are generally given a hardness number of 7.

Although it is not very accurate, it might be estimated that a mineral that cannot be scratched by your fingernail or a copper penny and yet which cannot cut glass may be estimated to have a hardness between 4 and 5.

If it barely cuts glass, it may be considered to have a hardness of 6.

Any mineral that can scratch another mineral having a hardness of 7, is considered as having a hardness between 8 and 10. If a mineral can scratch another with a hardness of 8, it is probably 9 or 10. If it can scratch a 9 mineral, it is probably 10.

Knowing the hardness helps us to limit the mineral as to where it may belong in the Mohs scale.

ACTIVITY:

1. Obtain 3 mineral samples, marked A, B, and C.
2. Prepare a chart of hardness, using fingernail, copper penny, and glass tests.
3. Determine the approximate hardness of samples A, B, and C.
4. Check with Mohs scale (pg. 9 of MASTERING EARTH SCIENCE).
5. What is your guess as to the names of the minerals (or what mineral do they resemble in hardness as given on the Mohs scale)?
6. Observe the Mohs scale display.

WRITE UP THE ABOVE EXPERIMENT IN THE FIVE STEPS.

EXPERIMENT C

BREAKAGE vs CRYSTALS

WHAT DID YOU NOTICE ABOUT THE WAY SOME OF THE MINERALS WHERE BROKEN?

If the break is irregular, with no particular shape or form, it is called FRACTURE.

If the break appears to have some form, it is usually called CLEAVAGE. A cleavage usually takes place along definite areas and may show flat surfaces.

There are six common types of cleavage:

1. one way (mica)
2. two way at right angles (feldspar)
3. two way not at right angles (hornblende)
4. three way at right angles (galena)
5. three way not at right angles (calcite)
6. four way (fluorite)

As far as fractures are concerned, one common type is found when quartz fractures. This breakage looks like the imprint of a shell and is called CONCHOIDAL.

Fractures may also be rough looking or splintery. (brucite)

Sometimes cleavage may be fonfused with what is called "crystal" form, son one must be alert to recognize certain differences although these are not always easy to find. All minterals have a definite atomic arrangement of their elements, just as the atoms of which we are made have their definite atomic arrangements. Such an arrangement in minerals is called a "crystal." We should not expect, however, that all crystals we find will be perfect in shape because very often impurities and other factors interfere.

CRYSTALS may be thought of as solids with smooth planes or faces. The problem lies in the fact that very often cleavage planes are parallel to the crystal faces and one may be confused with the other. One helpful clue to distinguishing between a crystal face and cleavage is the pearly luster of cleavage as against the smooth, shy in face of a crystal and, sometimes, small steplike surface on the outside.

EXPERIMENT C
BREAKAGE vs CRYSTALS
- 2 -

Crystallography, the science of crystals, is so complicated that it is now being studied as a separate subject. Some day you may wish to study this science. In the meantime, if any of you are interested, the study of crystals can be fun if you take up the hobby of crystal growing.

ACTIVITY:

1. Using specimens A, B, C, make a chart indicating cleavage or fracture.

2. Study the set of crystal samples.

3. Construct crystal forms from heavy paper:

    a. isometric or cubic (galena, pyrite, halite)

    b. tetragonal (chalcopyrite)

    c. hexagonal (quartz, hematite)

    d. orthorhombic (sulfur, olivine, topaz)

    e. monoclinic (gypsum, mica, augite)

    f. triclinic (albite, labradorite)